

US009531027B2

(12) United States Patent

Tender

(10) Patent No.: US 9,531,027 B2

(45) **Date of Patent: Dec. 27, 2016**

(54) METHOD AND APPARATUS FOR GENERATING ELECTRICAL POWER USING SUNLIGHT AND MICROORGANISMS

(75) Inventor: Leonard M. Tender, Bethesda, MD

(US)

(73) Assignee: The United States of America, as represented by the Secretary of the

Navy, Washington, DC (US)

(*) Notice: Subject to any disclaimer, the term of this

patent is extended or adjusted under 35

U.S.C. 154(b) by 1275 days.

(21) Appl. No.: 12/716,118

(22) Filed: Mar. 2, 2010

(65) Prior Publication Data

US 2010/0224246 A1 Sep. 9, 2010

Related U.S. Application Data

- (60) Provisional application No. 61/156,903, filed on Mar. 3, 2009.
- (51) Int. Cl. H01L 31/00 (2006.01) H01M 8/16 (2006.01) H01M 8/06 (2016.01)
- (52) **U.S. Cl.**CPC *H01M 8/16* (2013.01); *H01M 8/0606* (2013.01); *Y02E 60/527* (2013.01)

(56) References Cited

201

U.S. PATENT DOCUMENTS

4,117,202 A *	9/1978	Beck 429/2
5,427,871 A	6/1995	Garshol et al.
6,913,854 B1	7/2005	Alberte et al.
7,550,224 B1	6/2009	Tender et al.
8,148,019 B2	4/2012	Tender
.0/0081014 A1	4/2010	Tyce et al.

OTHER PUBLICATIONS

R.S. Berk and J.H. Canfield, "Bioelectrochemical Energy Conversion", Applied Microbiology, vol. 12 p. 10-12, 1964.*

Conlan, et al. Applied and Environmental Microbiology, Nov. 2005 p. 7442-7452. vol. 71, No. 11.*

Rosenbaum, et al. "In Situ Electrooxidationof photobiological hydrogen in a photobioelectrochemical fuel cell based on rhodobacter sphaeroides" Environ. Sci. Technol., 2005, 39, p. 6328-6333.*

Nandi, et al. "Microbial Production of Hydrogen" An Overview, Critical Reviews in Microbiology, 24, p. 61-84, 1998.*

LaLiberte, et al. "Survival of *Escherichia coli* in lake bottom sediment", Applied and Environmental Microbiology, 1982, 42, 623-628.*

Reimers et al., "Harvesting Energy from the Marine Sediment-Water Interface" Environ. Sci. Technol. 2001, 35, 192-195.

(Continued)

Primary Examiner — Marla D McConnell (74) Attorney, Agent, or Firm — US Naval Research Laboratory; Joseph T. Grunkemeyer

(57) ABSTRACT

Systems and methods are presented for generating and storing electric power in which a microbial solar cell is provided in a sealed container with photosynthetic organisms that generate reactants of the microbial fuel cell and the products of the microbial fuel cell from sunlight received through the container.

25 Claims, 3 Drawing Sheets

